

ACCELERATOR DIVISION ADMINISTRATIVE PROCEDURE

ADAP-11-0001

BEAM PERMITS, RUN CONDITIONS, and STARTUP

RESPONSIBLE DEPARTMENT: ESH&Q RPE

Prepared By *Nancy Lauten* DATE 9/28/16
ESH&Q AD RSO

Reviewed By *[Signature]* DATE 9/28/16
ESH&Q RPE Manager

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AD Operations Department Head

Approved By *Paul C. Goropod for Sergei Nagaitsev* DATE 9/28/16
Accelerator Division Head

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1.0 Purpose and Scope

The purpose of this procedure is to describe how the Accelerator Division (AD) complex is turned back on after extended shutdowns or after extensive maintenance or improvement work has taken place. An extended shutdown is defined as a shutdown that is typically greater than a month long. This procedure is also used as a driver to generate Beam Permits and Running Conditions that define operational parameters. This procedure can be executed whenever it is deemed necessary to formally review a given startup or operational change. This procedure does not address the shorter, controlled shutdowns that occur during the course of a run for maintenance and repair of specific components, or improvements to a few specific subsystems.

1.1 Policy

It is the Accelerator Division Policy that beam will not be introduced into any accelerator or beamline enclosure until:

- a. equipment and components are configured in a manner to safely allow beam transport;
- b. operational beam limits have been established consistent with the requirements of the Accelerator Safety Envelope (ASE) contained in the current applicable Safety Assessment Document (SAD) and *Accelerator Division Administrative Procedure ADAP-11-0003, Approved Accelerator Beam Intensity Operating Limits.*

2.0 Responsibilities

2.1 ESH&Q AD Radiation Safety Officer (RSO)

The AD RSO will prepare and review the Beam Permit, Running Condition, and the System Start-Up Sign-off documents for compliance with the current Accelerator Safety Envelope (ASE), ADAP-11-0003, and Shielding Assessment for the area. (See attachments 1, 2, and 3, respectively).

2.2 ESH&Q Radiation Physics Engineering (RPE) Manager

The ESH&Q RPE Manager is responsible for ensuring this document is prepared and updated on an as-needed basis, to sign off on the relevant System Start-Up Sign-Off sheets, and reviewing and signing off on the Beam Permit.

2.3 AD Department Heads

All department heads are responsible for ensuring that the provisions relevant to their departments are carried out. In the event of a change in departmental procedure that affects startup, the AD department heads are responsible for ensuring that the Division Head or designee is informed. In addition the AD Department Heads (or their designees) are required to sign off on the relevant System Start-Up Sign-Off sheets and checklists.

2.4 AD Head

The AD Head is responsible for overseeing that the provisions of this procedure are carried out. The AD Head is responsible for approving the System Start-Up Sign-off, Beam Permit, and Run Condition documents, and for sending the appropriate memos to the Operations Department Head to allow for the start or restart of the various accelerator systems.

The AD Head is responsible for designating a major shutdown or initiating this procedure. Such a designation is accomplished by a memo to the AD Operations Department Head rescinding authorization to introduce, accelerate, or transport beam until re-authorized in writing as described in this procedure.

3.0 Startup Procedure

3.1 Beam Permits and Running Conditions

Prior to the start of any accelerator beamline, or experimental area, a Beam Permit and Running Condition shall be generated and placed in the Main Control Room (MCR) (Attachments 1 and 2). The Beam Permit and Running Condition identify ASE and Operating Limits allowed for the appropriate system within the current ASE, ADAP-11-0003 limits, and define necessary actions for the Main Control Room operations crew to follow for off-normal occurrences.

Beam Permits are prepared and reviewed by the AD RSO to ensure compliance with the current appropriate system ASE and Operating Limits. Beam Permits are reviewed by the AD Operations Department Head, the AD Systems Department Head, the ESH&Q RPE Manager, and approved by the AD Head.

Running Conditions provide the Operations Department with the allowed or required safety related beamline parameters, configurations, and any additional safety related restrictions on operating the beam. These limits will be less than the Beam Permit. Running Conditions typically include:

- The Date Issued
- A Mode Identifier (some systems have multiple Running Conditions)
- The ASE intensity limit
- The Operating Intensity Limit
- The designated Critical Devices and enclosures protected
- Any Interlocked Radiation Detectors and monitoring channels (DEMUX)
- Any required special interlocks or setting types
- Devices or systems that must be disabled to allow access
- Associated Gates, Fences, or Passive Shielding Requirements
- Operational Comments such as what toroid monitors beam intensity

- Examples of Operating Limit combinations with respect to Particles/Pulse, energy and repetition rate
- Any special concerns that require approval before re-enabling the system
- Items that require documenting in the MCE electronic logs

Running Conditions are prepared by the AD Radiation Safety Officer and signed by the AD Systems Department Head, AD Radiation Safety Officer, AD Operations Department Head, and AD Head. Only the DEMUX channels of interlocked detectors and Operational Comments can be altered by the AD RSO using initials on existing documents. Any other modification to an existing Running Condition is covered by an Operating Note.

3.2 Operating Notes

Operating Notes may be issued by the AD RSO to the Operations Department that temporarily modifies an existing Running Condition to allow for special operating conditions that do not contradict shielding assessments. Typically, Operating Notes require intensities lower than the Running Condition allows. Operating Notes may include, but are not limited to, reduced intensities for commissioning beam, reduced intensities for temporary conditions that result in special concerns of a radiological nature, or special runs for beam studies. Operating Notes allow for an equivalent or more conservative modification to beam operations or intensities than the existing Running Condition. Operating Notes are in effect until they are rescinded by the AD RSO.

3.3 Sign-Offs and Checklists

Each Department Head shall sign the System Startup Sign-Off form (if applicable) indicating that all work is completed and that to their knowledge the system is ready to accept beam. In addition, the signature of the department head responsible for a particular system indicates that the radiation shielding for the system is configured as described in the current shielding assessment. The AD RSO signature indicates concurrence that the radiation shielding and the Radiation Safety Interlocks are configured as described in the current shielding assessment.

3.4 System Turn-On

3.4.1 *Generic Conditions*

A valid Beam Permit, Running Condition and System Start-Up Sign-off (see Attachments 1, 2, 3) are required to be completed before a given beamline system may accept and/or accelerate beam.

System operation is initiated by a memo that is sent by the AD Division Head to the AD Operations Department Head indicating that a system is ready for beam transport.

4.0 Documentation

Copies of all Beam Permits, Running Conditions, and System Start-Up Sign-off forms will be retained by AD Headquarters. Active Beam Permits, Running Conditions, and Operating Notes (if applicable) for all accelerator systems will be viewable in the Main Control Room.

5.0 Distribution

An electronic controlled copy of this procedure is maintained on the AD ES&H web site at:
http://ad-esh.fnal.gov/ad_adap.html

6.0 Attachment 1 - Example Beam Permit



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BEAM PERMIT

Linac Accelerator Safety Envelope (ASE) Limit

The maximum hourly beam power authorized through the Linac accelerator is limited to:
 1.77×10^{19} protons at 400 MeV.

No accelerator or beam line will transmit beam without an operational beam interlock safety system.

Linac Operating Limit

The operational limit for beam transmitted through the Linac is limited to:
 3.54×10^{17} particles per hour at 400 MeV.

Examples: Particles/hr = current (mA) x pulse length (μsec) x number of pulses/hr x 6.25×10^9

#1 35 mA of beam with a pulse length of 30 μsec at 15 Hz for one hour yields 3.54×10^{17} particles/hour
($35 \text{ mA} \times 30 \text{ μsec} \times 54000 \text{ pulses/hr} \times 6.25 \times 10^9 = 3.54 \times 10^{17} \text{ particles/hour}$)

#2 50 mA of beam with a pulse length of 30 μsec at 5 Hz for one hour yields 1.69×10^{17} particles/hour
($50 \text{ mA} \times 30 \text{ μsec} \times 18000 \text{ pulses/hr} \times 6.25 \times 10^9 = 1.69 \times 10^{17} \text{ particles/hour}$)

Special conditions and comments:

Reviewed by _____
Operations Department Head/Date

Reviewed by _____
Systems Department Head/Date

Reviewed by _____
ESH&Q RPI Manager/Date

Reviewed by _____
ESH&Q AD Radiation Safety Officer/Date

Approved by _____
Accelerator Division Head/Date

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10/8/16

7.0 Attachment 2 - Example Running Condition

	<h2 style="margin: 0;">Running Condition</h2> <h3 style="margin: 0;">Linac</h3> <p style="margin: 0;">October 8, 2016</p> <p style="margin: 0;">R.S.O. Gary Lauten</p>												
<p>Mode Identifier</p> <p>ASE Limit</p> <p>Operational Limit</p> <p>Critical Devices</p> <p>Enclosures Protected</p>	<p style="text-align: center;">Full Operation</p> <p style="text-align: center;">1.77 E19 particles/hr at 400 MeV</p> <p style="text-align: center;">3.54 E17 particles/hr at 400 MeV</p> <p style="text-align: center;">L:LVV and RFQ Low Level RF</p> <p style="text-align: center;">Linac and all areas downstream</p> <p style="text-align: center;"><u>Interlocked Radiation Detectors</u></p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Detector Type</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Detector Trips</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Demux</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Location</u></th> </tr> </thead> <tbody> <tr> <td style="border-bottom: 1px solid black;">See Page 2</td> <td style="border-bottom: 1px solid black;">L:LVV (Vacuum Gate Valve)</td> <td style="border-bottom: 1px solid black;">See Page 2</td> <td style="border-bottom: 1px solid black;">See Page 2</td> </tr> <tr> <td></td> <td>RFQ Low Level RF</td> <td></td> <td></td> </tr> </tbody> </table>	<u>Detector Type</u>	<u>Detector Trips</u>	<u>Demux</u>	<u>Location</u>	See Page 2	L:LVV (Vacuum Gate Valve)	See Page 2	See Page 2		RFQ Low Level RF		
<u>Detector Type</u>	<u>Detector Trips</u>	<u>Demux</u>	<u>Location</u>										
See Page 2	L:LVV (Vacuum Gate Valve)	See Page 2	See Page 2										
	RFQ Low Level RF												
<p><u>Other Requirements</u></p> <p><u>Special Interlocks:</u> The CDC Inputs required to obtain a Linac Beam Permit may all be found on the Safety System Status pages. The status of the RFQ Low Level RF is monitored on L:RFQDS1.</p> <p>The Backup Devices are the Ion Source Extractor PS AC Contactor L:AEXTSV and L:BEXTSV</p> <p><u>Access Devices:</u> L:LVV must be closed and RFQ Low Level RF must be OFF to access Linac.</p> <p><u>Special Concerns:</u> No Access to the Linac enclosure while the high energy (Klystron) gradients are energized, and access is not allowed unless the Low Energy Gradients are below 50% nominal gradient.</p> <p><u>Gates, Fencing, and Passive Shielding Requirements:</u> There is no access to radiologically fenced areas without prior RSO approval. The RFQ, ion source, (and former E-Cockroft-Walton) area directly north of the Linac enclosure is posted as a Radiation Area and is locked (AC-4 cored lock) to prevent access by non-Radiological Worker trained personnel. Routine access to this Radiation Area by Radiological Worker trained personnel is permitted during beam operations. (27) Lower Level penetrations must be locked with a LIN C cored padlock prior to operation. (8) penetrations on top of the Linac Beam must be locked with PAD 118 and LIN E cored padlocks. The downstream portion of the Booster Chute (on the booster side) must be covered and locked with a PAD 118 cored padlock.</p>													
<p><u>Operational Comments</u></p> <p>The maximum beam energy is limited to 400 MeV. The maximum charge transmitted through the Linac is limited to 3.54 E17 particles/hour at 400 MeV kinetic energy.</p> <p>Examples: 35 mA of beam with a pulse length of 30 μsec at 15 Hz for 1 hour yields 3.54 E17 particles/hour. (35 mA x 30 μsec x 54000 pulses/hr x 6.25 E9 = 3.54 E17 particles/hour)</p> <p>50 mA of beam with a pulse length of 30 μsec at 5 Hz for 1 hour yields 1.69 E17 particles/hour. (50 mA x 30 μsec x 18000 pulses/hr x 6.25 E9 = 1.69 E17 particles/hour)</p>													
<p>R.S.O. approval also signifies that all necessary Interlock Tests have been completed and Removable Shielding is installed.</p>													
<p>Ops. Dept. Head Approval _____</p>	<p>R.S.O. Approval _____</p>												
<p>Sys. Dept. Head Approval _____</p>	<p>AD Head Approval _____</p>												
<p>Page 1 of 2 ADAP-11-0001</p>													



Running Condition

Linac

October 8, 2016

Gary Lauten

R.S.O.

Note: Interlocked detectors are limited to 10 trips per hour. RSO approval is required if there are more than ten interlocked detector trips in an hour. All interlocked detector trips and RSO approvals to reset if required, shall be documented in the MCR E-log.

<u>MUX</u>	<u>Location</u>	<u>Quality Factor</u>	<u>Type</u>	<u>Integrate/Rate Mode</u>
2-027	Linac Dump #1 Berm US	5	Chipmunk	Rate
2-028	Linac Dump #1 Berm DS	5	Chipmunk	Rate
2-031	Linac Enclosure TL #1	5	Chipmunk	Rate
2-032	Linac LL Gallery TL #2	5	Chipmunk	Rate
2-033	Linac LL Gallery TL #3	5	Chipmunk	Rate
2-034	Linac LL Gallery TL #4	5	Chipmunk	Rate
2-035	Linac LL Gallery TL #5	5	Chipmunk	Rate
2-036	Linac LL Gallery TL #6	5	Chipmunk	Rate
2-037	Linac LL Gallery TL #7	5	Chipmunk	Rate
2-038	Linac LL Gallery TL #8	5	Chipmunk	Rate
2-039	Linac LL Gallery TL #9	5	Chipmunk	Rate
2-040	400 MeV Labyrinth Leg #2	4	Scarecrow	Rate
2-042	Linac Enclosure TL #3	4	Scarecrow	Rate
2-044	Booster Chute	5	Chipmunk	Rate
2-053	Booster Tunnel Dump #1	5	Chipmunk	Rate

R.S.O. approval also signifies that all necessary Interlock Tests have been completed and Removable Shielding is installed.

Ops. Dept. Head Approval _____ R.S.O. Approval _____

Sys. Dept. Head Approval _____ AD Head Approval _____

8.0 Attachment 3 - Example System Sign-Off



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SYSTEM SIGN-OFF

The signatures below indicate that work done on the system since the last period of operation has been completed and that the systems are ready for restart of beam operation. Indicate N/A for departments that did not do any work on the system.

SYSTEM BEING SIGNED OFF: **Linac NIF MuCOOL Booster [8-GeV Line-MI-10 Region]**
(Circle as Applicable) **[MI-20-MI-62/Recycler] BNB NuMI Muon Switchyard**
Meson Primary MT MC NM FAST PIP-II _____

<u>DEPARTMENT</u>	<u>DATE</u>	<u>SIGNATURE (Department Head/Designee)</u>
Controls	_____	_____
Cryogenics	_____	_____
E/E Support	_____	_____
RPE Manager	_____	_____
LSO	_____	_____
External Beamlines	_____	_____
Instrumentation	_____	_____
Interlocks	_____	_____
Main Injector	_____	_____
Mechanical Support	_____	_____
Muon	_____	_____
Operations	_____	_____
Proton Source	_____	_____
RF	_____	_____
ENG Support	_____	_____
Target Systems	_____	_____

The _____ radiation shielding meets the requirements documented in the _____
_____ shielding assessment.

Approved by _____ Date _____
Department Head

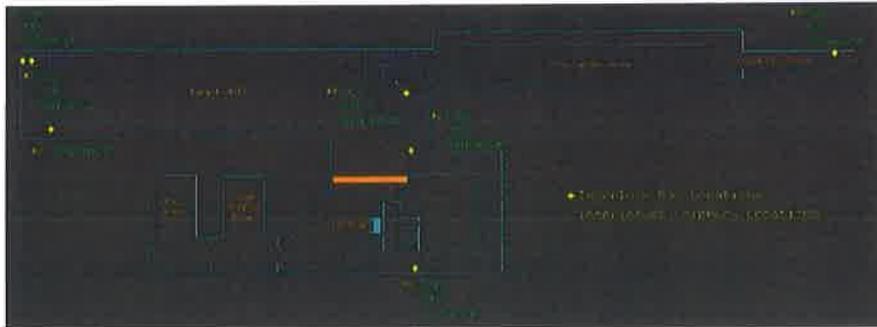
Comments and special conditions:
=====

FINAL APPROVALS

Department Head _____ Date _____
ESH&Q AD RSO _____ Date _____
Accelerator Division Head _____ Date _____

9.0 Attachment 4 - Example Operating Note

Operating Note **NuMI** **Low Intensity Target Scans** September 2, 2013



The current Running Condition for NuMI HEP operation is modified as follows:

Low intensity scans will be conducted to verify target position. The intensity must be temporarily reduced to low intensity (no more than $1.2 \text{ E}12$ Proton/pulse, no faster than 10 seconds between pulses) at 120 GeV because the “R-blocks” are not sealed. Intensity limit is as follows:

$4.32 \text{ E}14$ protons/hr
 $1.2 \text{ E}12$ protons per pulse, 360 pulses per hour

Special Concerns: The purpose of this Operating Note is to conduct low intensity target scans in order to adjust and verify its position. The T-blocks are in chase, concrete R-block covers are on, and target hall shield wall door is closed.

NuMI “R-Blocks” are in place, however they are not sealed against air leaks. It is acceptable to run beam at low intensity as stated above during the time when the “R-blocks” are not sealed.

This Operating Note is in effect from September 2, 2013 until it is rescinded by the AD RSO. NuMI HEP operations may NOT resume until approved by the AD RSO.

G. Lauten